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(56) Documents cited

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(58) Field of search
A3V

(54) Seat belt tension relief arrangements

(57) A vehicle seat belt system, in which the belt is withdrawn for use from a retractor against a spring bias, includes means for rendering the spring bias at least partially ineffective when a switch associated with a belt buckle is closed to indicate that the belt is in use. The belt is clamped, rotation of the retractor spool in the belt withdrawal direction is prevented by a ratchet and pawl arrangement, or spool rotation is opposed frictionally.

In the latter arrangement, a solenoid 26 causes frictional engagement between plates 24 and 28 so that a braking effect is applied to retractor spring 16. Solenoid 26 is actuated by a buckle switch.

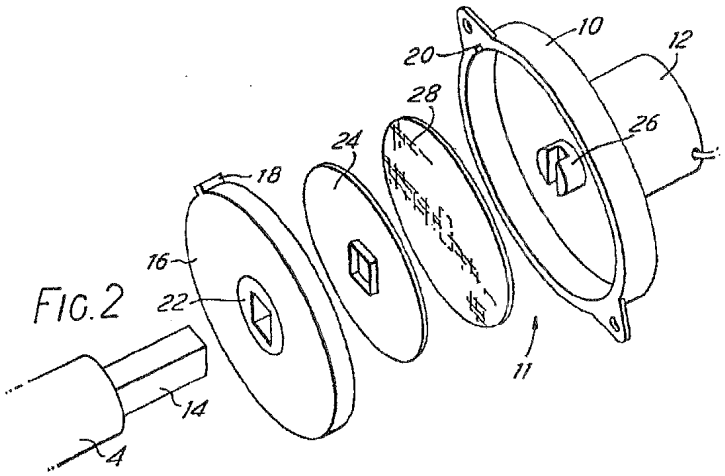

FIG. 2

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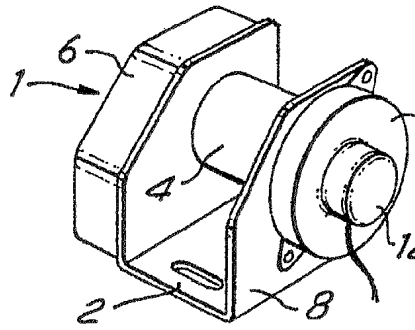

FIG.1

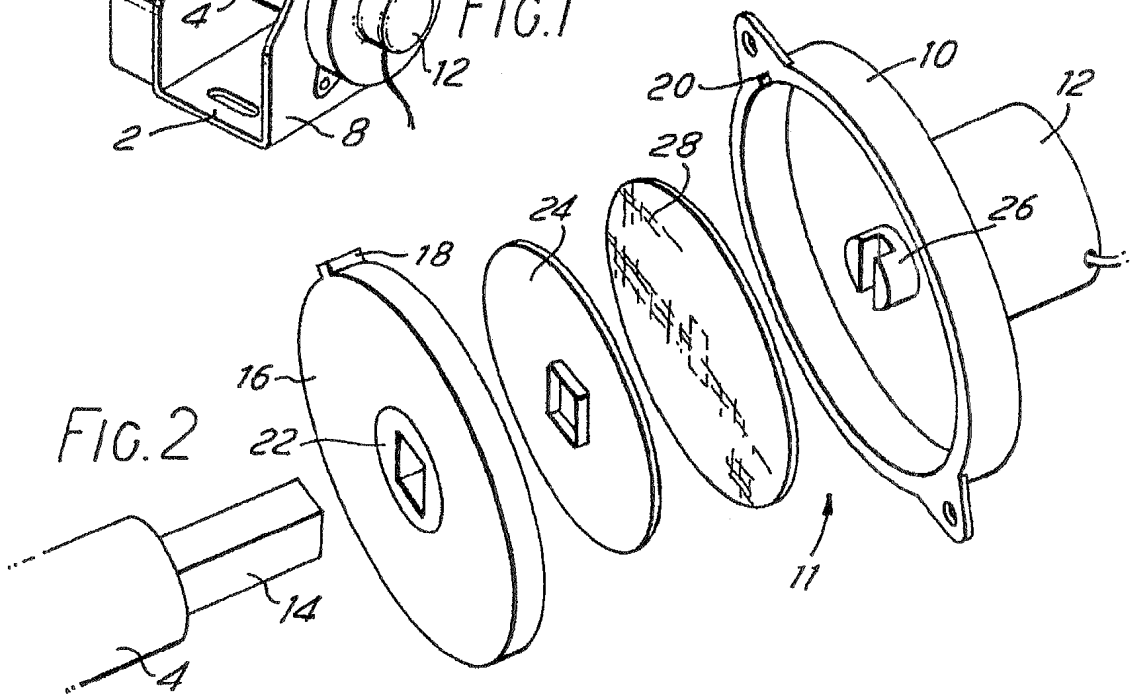

FIG.2

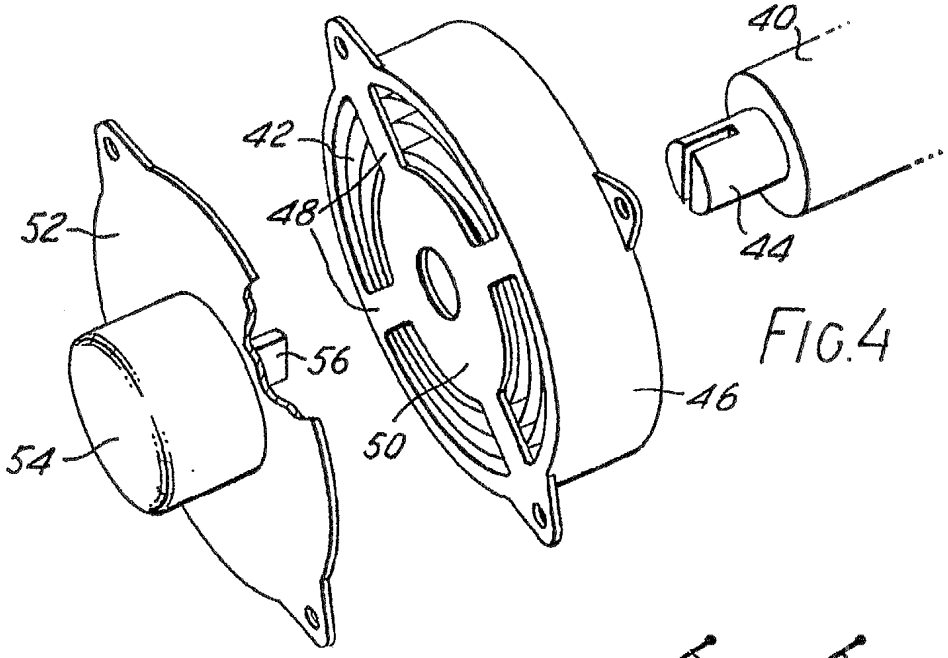

FIG.4

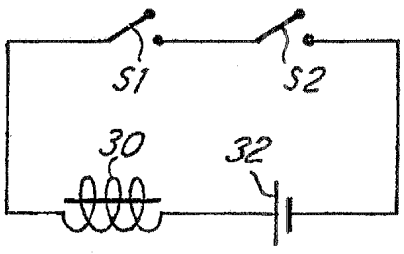

FIG.3

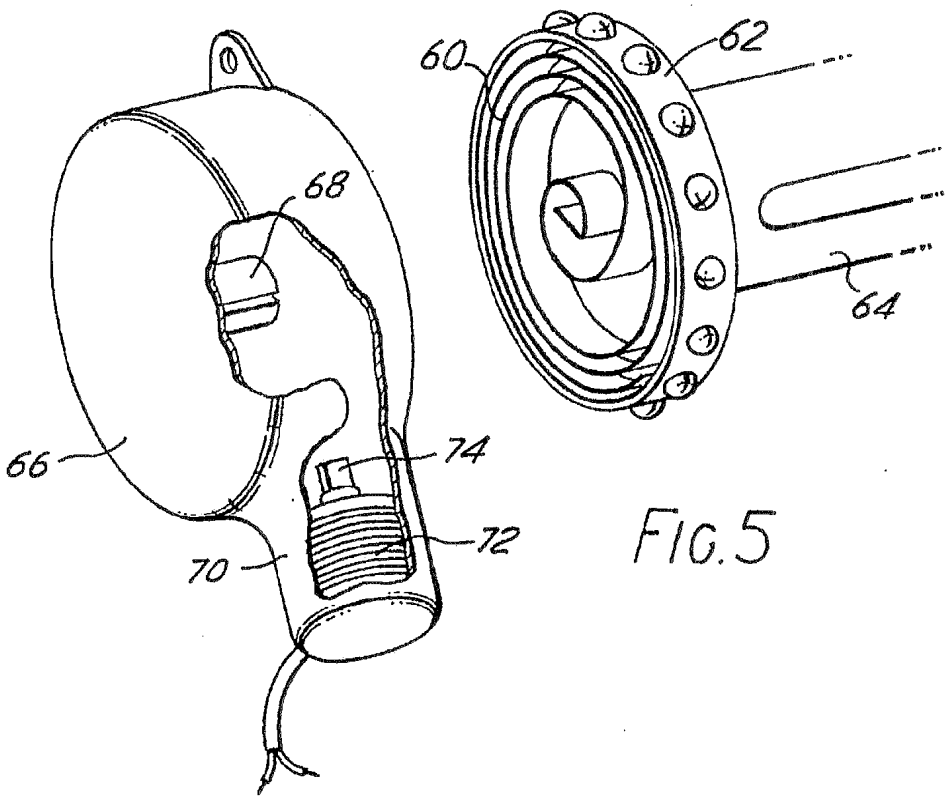

FIG.5

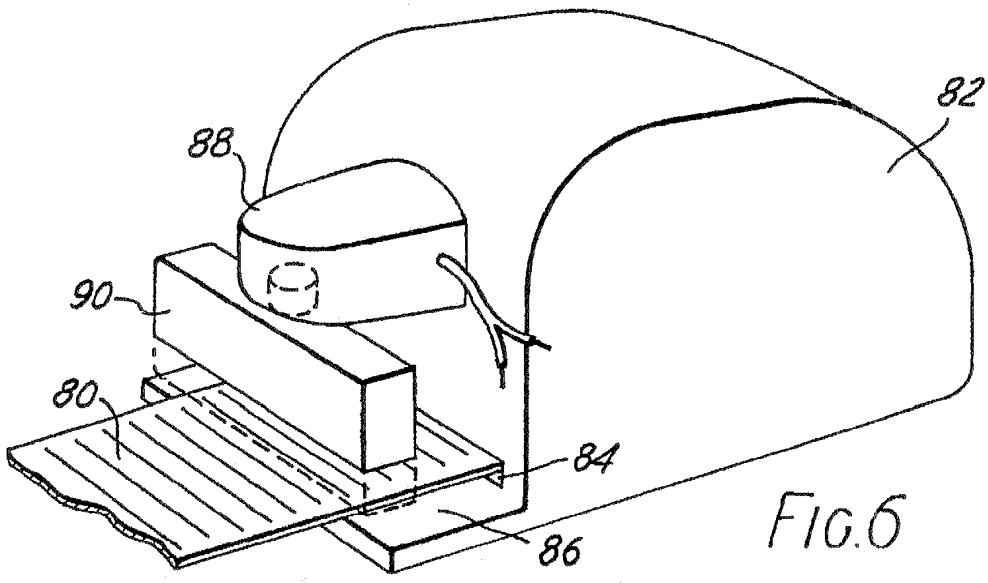

FIG.6

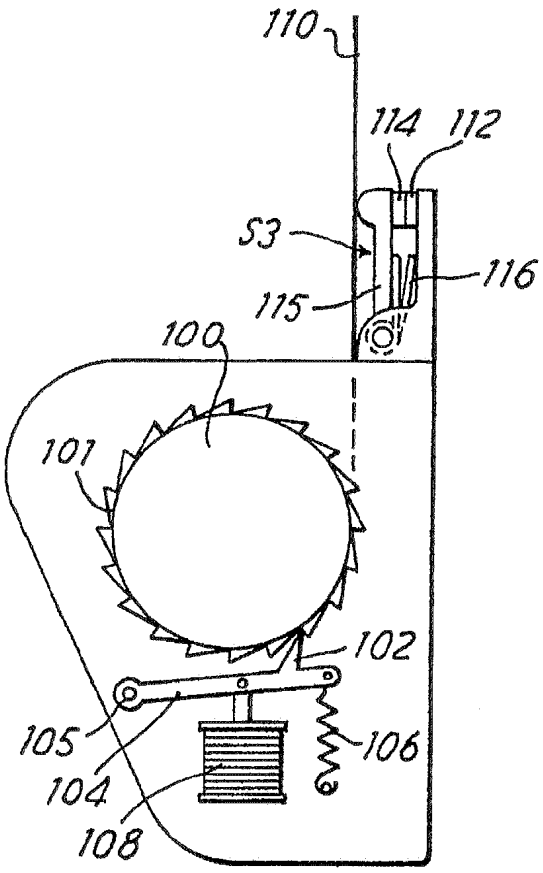

FIG.7

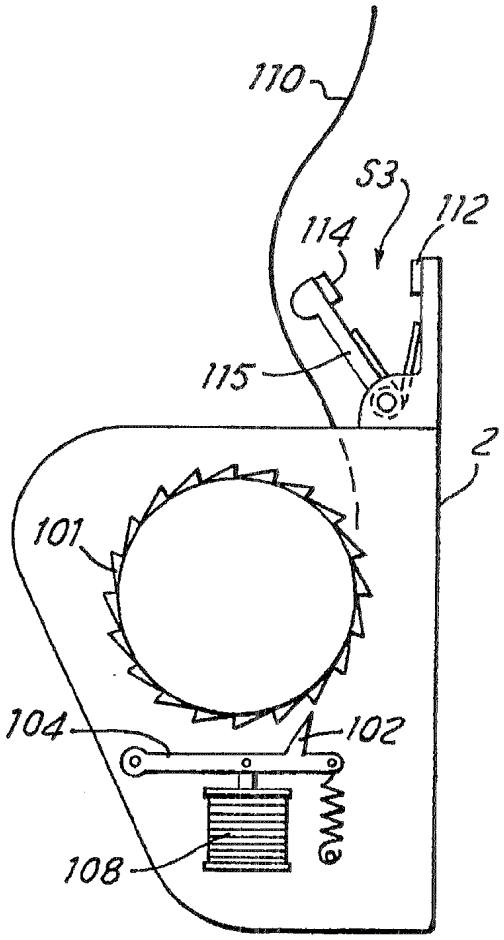

FIG.8

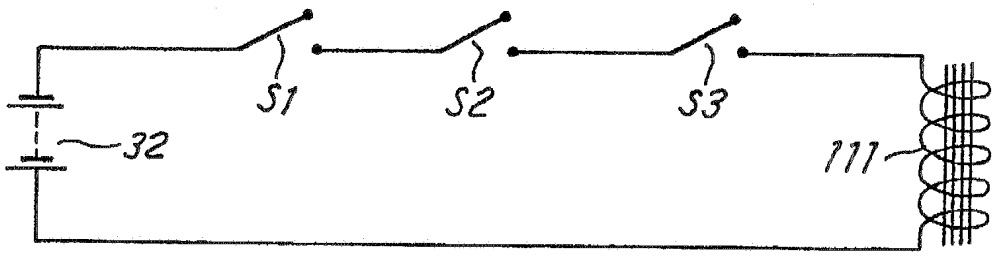

FIG.9

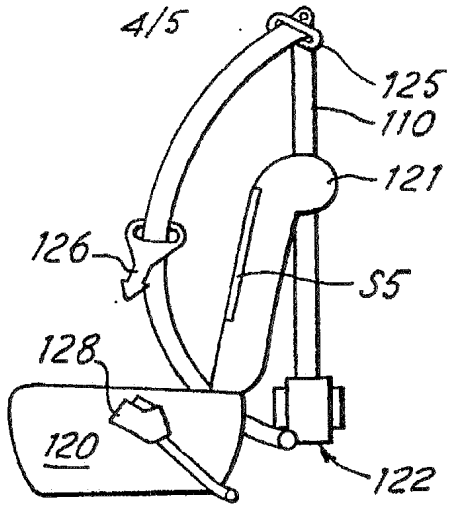

FIG.10

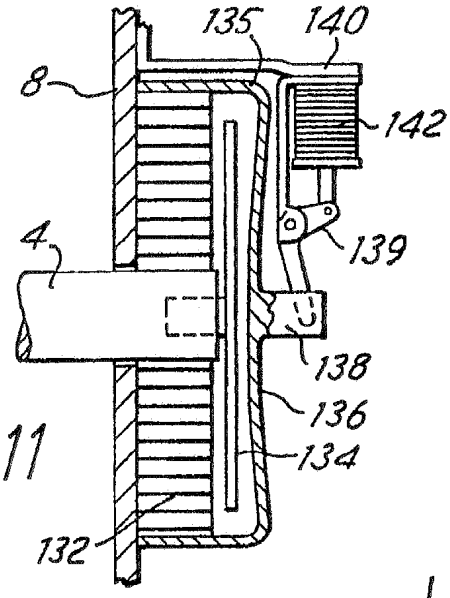

FIG.11

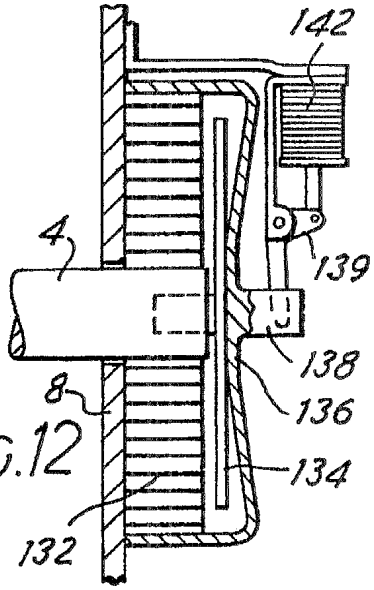

FIG.12

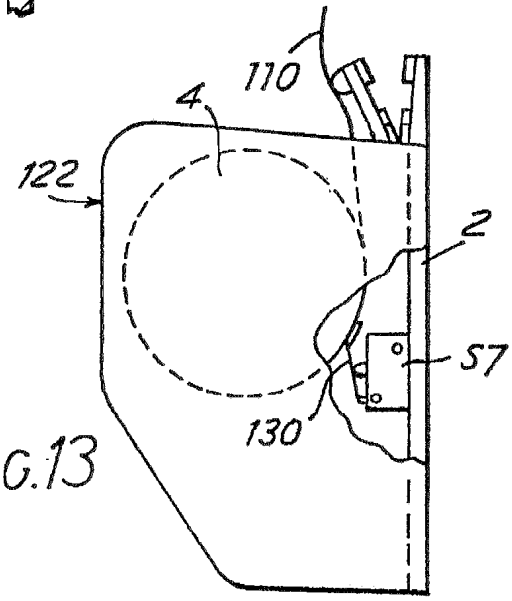

FIG.13

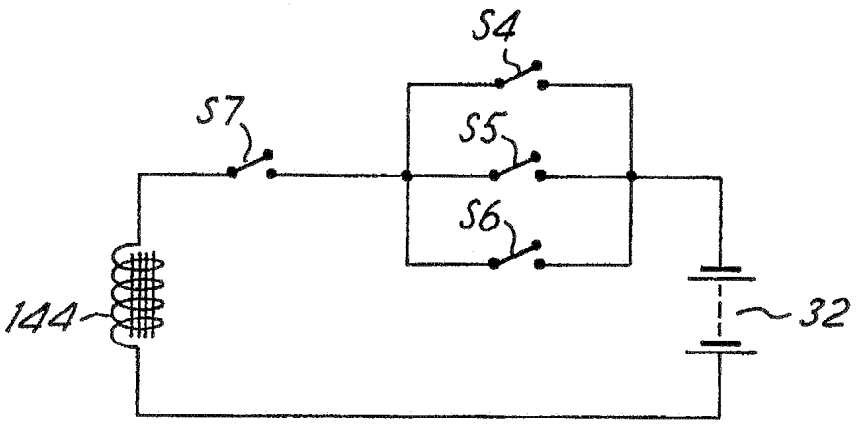

FIG.14

S4	S5	S6	S7	142
C	C	C	C	E
C	C	O	C	E
C	O	C	C	E
O	C	C	C	E
O	O	O	C	D
C	C	C	O	D
C	C	O	O	D
C	O	C	O	D
O	C	C	O	D
O	O	O	O	D

FIG.15

SPECIFICATION

Seat belt tension relief arrangements

The invention relates to the relief of tension in a seat belt when withdrawn for use from a retractor.

Vehicle seat belt systems conventionally comprise a belt which extends in use diagonally downwardly across the chest or torso of the wearer to a buckle at one side of the seat and thence across the wearer's lap to an anchorage at the other side. The upper end position of the diagonal or shoulder portion of the belt may be defined by a guide or running loop to which the belt extends from a retractor incorporating a retraction spring by which the belt is rewound after use. The retractor also includes emergency locking means responsive to belt and/or vehicle acceleration to prevent further belt withdrawal.

The retraction spring exerts a continuous tension on the belt in use which can be a source of discomfort to the user. The invention is concerned with the relief of this tension so as to minimize or eliminate this discomfort.

The invention thus provides a tension relief device for the belt of a seat belt system, the system including a retractor from which the belt is withdrawn for use against a retraction spring, the device being arranged to apply a force opposing or preventing retraction of the belt in response to the system's being put into use.

The device of the invention can comprise a solenoid operated brake device acting on the spool, on the retraction spring directly, or on the belt. It can readily be embodied in a form which permits it to be incorporate in a retractor of conventional design without substantial modification of that design.

The invention also provides a belt retractor for use in a vehicle seat belt system, the retractor having a spool biassed by a retraction spring to wind the belt thereon, and means for opposing or preventing the application of the retraction spring bias to the belt when the belt is in use.

The fact that the seat belt system is in use can be sensed in any convenient way, depending on the nature of the system. In a manual system, in which the user is required to fasten a buckle, an electrical condition responsive device can be associated with the buckle so as to signal the use of the system as long as the buckle is fastened.

Thus, a seat belt system embodying the invention can include a simple circuit having the vehicle battery or other power source in series with a solenoid requiring to be energized to apply a frictional retraction-opposing force, and a normally open buckle switch which closes to complete the circuit when the buckle is fastened. Preferably, the force applied by the device does not prevent belt withdrawal during use of the system, so as to permit the user to bend forward in his seat, for example. Preferably also belt retraction is not prevented, so that any extra length of belt so withdrawn is retracted. A normally open seat switch can be included in series with the buckle switch if desired.

In another seat belt system embodying the invention, belt retraction is opposed or the retractor is locked against belt retraction in response to an electrical signal dependent on buckle connection, or on other indication that the system is being placed out of use, provided that tension in the belt has also been sensed. Further withdrawal of the belt, as when the user of the system leans forward in his seat, is not prevented but belt retraction, of the slack length of belt so withdrawn when the user moves to his usual position, can take place freely until the belt has been sufficiently wound in to achieve sufficient tension to operate a second electrical condition responsive device.

In a further seat belt system embodying the invention, belt retraction is normally opposed but is released, as by energisation of a solenoid, in response to a signal that the system is being put out of use, as by disconnection of the buckle, or to the user's leaning forward in his seat, as in response to operation of a switch or other sensor in the seat backrest portion, or on the sensing of a slack length of the belt, as by a tension responsive device, provided that a significant length of the belt has been withdrawn from the retractor.

The invention is further described below with reference to the accompanying drawings, in which:

Figure 1 is a perspective view of a vehicle seat belt retractor incorporating a pressure relief device in accordance with the invention;

Figure 2 is an exploded perspective view on a larger scale of the pressure relief device incorporated in the retractor of Figure 1;

Figure 3 illustrates a circuit associated with the retractor of Figures 1 and 2;

Figure 4 is an exploded perspective view of a pressure relief device incorporated in a second retractor in accordance with the invention;

Figure 5 is an exploded perspective view of a pressure relief device incorporated in a third retractor in accordance with the invention;

Figure 6 is a perspective view of a fourth retractor incorporating a pressure relief device in accordance with the invention;

Figures 7 and *8* are schematic end views of a fifth retractor incorporating a pressure relief device in accordance with the invention, shown in respective different conditions;

Figure 9 illustrates a circuit associated with the retractor of Figures 7 and 8;

Figure 10 is a schematic side view of a vehicle seat and of the vehicle seat belt system including a sixth retractor in accordance with the invention;

Figures 11 and *12* are partial sectional side views of the retractor of Figure 10;

Figure 13 is a schematic side view, with parts broken away, of the retractor of Figure 10;

Figure 14 illustrates a circuit associated with the retractor of Figure 10; and

Figure 15 is a table explaining the operation of the circuit of Figure 14.

Figure 1 shows a vehicle seat belt retractor 1, the cover of which has been removed to show a channel-shaped frame 2, between the side walls of which is journalled a spool 4. A vehicle seat belt (not shown) can be unwound for use from the spool 4 against the tension of a retraction spring. Emergency

locking arrangements responsive to retractor and/or belt acceleration to prevent further belt withdrawal are received within a housing 6 secured on the outer side of one of the side walls of the frame 2. Located externally of the other side wall 8 of the frame is the retractor spring. The features of the retractor 1 so far mentioned are common to all the retractors illustrated herein and are accordingly not specifically referred to in connection with retractors later described.

The retraction spring of the retractor 1 is received in a housing 10 having a smaller diameter axial extension portion 12 accommodating the tension relief device 11 shown in Figure 2. The spool 4 has a square section end portion 14 projecting outwardly through the side wall 8 into the housing 10. The retraction spring is accommodated within a flat cup member 16 having an external radially projecting key 18 received in a keyway 20 in the housing 10 so as to be held against rotation. Journalled in a central aperture of the floor of the cup is a hub 22 apertured to receive the spool end portion 14 and rotate therewith. The inner end of the coiled retraction spring is secured to the hub, the other end being secured to the tubular wall of the cup member 16.

The spool end portion 14 extends beyond the hub 22 and is received in the central aperture of a circular friction plate 24 provided with a square shaped central aperture so as to rotate with the spool 4. Within the housing portion 12, there is accommodated a solenoid with an armature movable axially as a plunger 26 and spring biassed outwardly, away from the spool 4 to a normal, inoperative, position. Within the housing 10, the solenoid plunger non-rotatably carries a pressure plate 28 which is moved on actuation of the solenoid into engagement with the friction plate 24.

As shown in Figure 3, the solenoid winding 30 is connected in series with a power source 32, which will normally be the vehicle battery, a normally open seat switch S1, and a normally open buckle switch S2. A further normally open switch arranged to be closed with operation of the vehicle ignition key may also be placed in series with the switches S1 and S2.

When the vehicle is out of use, both switches S1 and S2 are open, the solenoid is de-energised so the pressure plate is spaced from the friction plate 24. When the user of the seat belt system occupies his seat the seat switch S1 closes but the solenoid winding 30 is still not energised because the buckle switch S2 remains open. The user then pulls a free seat belt buckle part across his chest, so withdrawing belt from the retractor 1 against the retraction spring, until the free buckle part can be assembled with a vehicle mounted buckle part. Fastening together of the two buckle parts closes the buckle switch S2, and this completes the circuit to energise the solenoid. The non-rotatable pressure plate 28 is consequently urged against the friction plate 24 carried by the spool 4 for rotation therewith.

Once the buckle has been fastened, the user no longer pulls on the belt against the retraction spring, and in the absence of the tension relief device 11, the retraction spring would pull in any slight excess length of the belt which might have been withdrawn. The braking effect of the engagement between the pressure and friction plates 24,28 however opposes this withdrawal, so that the tension of the retraction spring is not fully applied to the withdrawn belt and the user is not inconvenienced by the tension of the belt across his chest. The belt can still be further withdrawn against the braking effect of the pressure and friction plates 24,28, as if the user leans forward in his seat, and the belt will subsequently be retracted by the action of the retraction spring, again inhibited by the braking effect of the pressure and friction plates.

In the event of an emergency, a retractor acceleration sensitive locking mechanism in the housing 6 will lock the retractor against belt withdrawal, and if a belt acceleration sensitive mechanism is fitted the sudden sharp pull on the belt experienced as the user's body is thrown forward in the seat is sufficient to overcome the braking effect and cause the mechanism to effect locking.

When the seat belt system user leaves his seat, he first unfastens the buckle to open the buckle switch S2. This breaks the circuit to de-energise the solenoid, so the pressure plate 28 is withdrawn from the friction plate 24 under the spring bias acting on the plunger 26 and the retraction spring can wind the belt in without inhibition.

In the embodiment of Figure 4, the retractor spool 40 extends outwardly beyond the side wall (not shown) of the retractor frame to engage the inner end of a coiled retraction spring 42 by means of a stub shaft portion 4 with a split end. The spring 42 is housed within a drum 46 secured to the side wall, the outer end of the spring being secured to the inner wall of the drum. The outer end of the drum 26 carries or is formed with a diaphragm comprising four radial support webs 48, which extend to an integral central disc portion 50, and is closed by a plate 52 formed to provide a co-axial solenoid housing 54 containing a solenoid similar to that of Figures 1 and 2 and connected into a circuit corresponding to that of Figure 3. This solenoid has a plunger 56 which acts, when the solenoid is energised, to urge the central disc portion 50 of the diaphragm against the edges of the coiled retraction spring 42, so inhibiting retraction. When the solenoid is de-energised the resilience of the support webs 48 assists the return spring in the solenoid to disengage the disc portion 50 from the spring 42.

In the retractor of Figure 5, the inner end of a retractor spring 60 is fixed, the outer end being secured to the cylindrical wall of a cup-shaped member 62 carried by an extension of the spool 64 projecting through the frame side wall (not shown). The spring 60 and the cup member 62 are received within a housing 66 secured to the side wall and provided with a fixed central spigot 68 for connection to the inner end of the spring. A lateral extension portion 70 of the housing 66 accommodates a solenoid 72 generally of the same structure as the solenoids previously described. The solenoid plunger however carries at its free end a pawl 74 engageable with series of protrusions or teeth 76 on the outer side of the cylindrical wall of the spool cup member 62. The solenoid 72 is again connected into

a circuit corresponding to that of Figure 3, so that the pawl 74 is withdrawn from the teeth 76, allowing normal belt withdrawal, until the buckle is fastened. The pawl 74 is then projected radially inwardly to engage between the teeth 76 and so inhibit the action of the retractor spring 60. The pawl 74 and the teeth 76 are however shaped to permit further belt withdrawal and retraction, by ratcheting the teeth past the pawl.

In the retractor of Figure 6, the tension relief device of the invention acts on the seat belt 80 directly, instead of by way of the spool or retractor spring. The retractor has a housing 82 with a slot 84 from which the belt 80 is withdrawn and retracted, the retractor and housing being conventional except that at the centre web of the frame extends beyond the slot 84 to support or provide a resistance surface 86 adjacent the belt. Also, the housing 82 has a subhousing 88 projecting therefrom to accommodate a solenoid in a position to overlie the resistance surface 86. The solenoid within the subhousing 88 corresponds to the solenoids previously described but the free end of the plunger extends outwardly of the subhousing towards the resistance surface and carries a brake pad 90. The solenoid is again connected into the circuit of Figure 3, so that when it is actuated, the belt 80 is clamped between the brake pad 90 and the resistance surface 86 with a braking force which is sufficient to relieve tension in the belt but not to prevent further belt withdrawal and retraction.

In the retractor of Figures 7 and 8 a spool 100 is provided externally of one of the side walls of the frame 2 with a ratchet 101 engageable by a pawl 102 provided on a lever 104 pivoted at 105 on the side wall. The lever projects beyond the pawl 102 away from the pivotal mounting 105 to a connection with a tension spring 106, the other end of which is secured to the side wall. The spring 106 normally holds the lever 104 in the generally horizontal position shown in Figure 8 in which the pawl is spaced from the ratchet wheel. Between the pivotal connection 105 and the pawl 102 the lever 104 is pivotally connected to the armature of a solenoid 108 mounted on the side wall. When energised, the solenoid 108 extends the armature therefrom, so pivoting the lever upwardly to engage the pawl 102 with a tooth of the ratchet wheel 101, as shown in Figure 7. The ratchet wheel teeth and the pawl 102 are such that rotation of the spool 100 in the winding direction is then prevented, although the belt 110 can still be pulled out, with the pawl 102 ratcheting over the ratchet wheel teeth.

As shown in Figure 9, the winding 111 of the solenoid 108 is connected in circuit in series with the battery 32, the normally open seat switch S1, the normally open buckle switch S2 and a third switch S3 carried on the retractor frame 2. The switch S3 has a fixed contact 112 and a movable contact 114 on a pivotally mounted arm 115. The arm 115 is biassed by a spring 116, to the open position of Figure 8 and the switch maintains this position as long as the belt 110 is slack. Tension in the belt 110 however causes the portion of the belt immediately adjacent the retractor to straighten to move the arm 115 to the position shown in Figure 7 in which the contacts 112 and 114 engage and the switch is closed.

When the vehicle is out of use, all three switches S1, S2 and S3 will be open, the solenoid 108 is de-energised so the pawl 102 is held spaced from the ratchet wheel 101. When the seat is occupied, the occupant withdraws the belt 110 from the retractor. Although the resulting belt tension may close the switch S3, the solenoid 108 is not energised because the buckle switch S2 remains open, so belt withdrawal can proceed without noise resulting from ratcheting of the pawl 102 over the ratchet wheel teeth. When sufficient belt has been withdrawn, the user connects the buckle thus closing the switch S2. Normally a short excess length of belt is withdrawn, and the consequential slackness allows the switch S3 to remain open, so that the retractor spring can take up the slack. The belt tension is then sufficient to close the switch S3, so energising the solenoid 108 to relieve belt tension on the user.

In emergency conditions, the user will be thrown forward in the seat with ratcheting of the pawl 102 over the ratchet wheel teeth until the belt and/or vehicle sensitive locking mechanism comes into play. When the user wishes to divest himself of the seat belt, he will disconnect the buckle so opening the switch S2 to de-energise the solenoid to permit belt retraction.

Figure 10 shows a vehicle seat, having a seat portion 120 and a back portion 121, for use by the driver or a passenger, and associated with a seat belt system having a retractor 122 from which the seat belt 124 extends generally upwardly to a running loop 125 on the vehicle frame at a position about the user's shoulder and extending therefrom downwardly to a first buckle part 126 which can be releasably connected to a co-operating buckle part 128 on the other side of the seat from the retractor and the running loop, the second buckle part being secured to a vehicle anchorage by a cable or bracket or the like.

The buckle part 128 incorporates a normally closed switch S4 which is opened when the two buckle parts are connected together, and the seat back rest portion 121 incorporates a normally closed switch S5 which is opened when the seat occupant leans back against the backrest portion. The retractor 122 incorporates a switch S6 which is equivalent to the switch S3 of Figures 7 and 8, and a second switch S7 carried by the frame 2 and operated by a pivoted arm 13 biassed to engage the belt wound on the spool 4. The switch S7 is closed when the belt is in use, when the belt is not fully wound on the spool, but opens in response to movement of the arm 130 when the belt is wound in to the extent corresponding to non-use.

The spool 4 carries at the end thereof projecting outwardly beyond the retractor spring 132 a friction disc 134. The spring and friction disc are enclosed by a casing 135 including a diaphragm 136, suitably of resilient plastics material, which is normally biassed to engage the disc 134 so as to oppose rotation of the spool 4. An axially projecting portion 138 of the diaphragm 136 is however engaged by the free end of a two-arm lever 139 pivoted at the join of its two

arms on a bracket 140 mounted on the retractor frame 2, together with a solenoid 142, the armature of which is connected to the free end of the other arm of the lever. With the solenoid 142 de-energised, the diaphragm 136 engages the friction disc 134 as shown in Figure 12, but energisation of the solenoid effects pivotation of the lever 139 to separate the diaphragm from the friction disc.

As shown in Figure 14, the switches S4, S5 and S6 are connected in parallel with one another and in series with the switch S7, the vehicle battery 32 and the coil 144 of the solenoid 142.

As appears from Figure 15, in which C & O indicate that the relevant switch is closed and open respectively, and D & E respectively indicate de-energisation and energisation of the solenoid 142, the solenoid will be de-energised when the vehicle is out of use because the belt will be substantially completely wound onto the retractor spool, so switch S7 will be open although switches S4, S5 and S6 will be closed. When the seat is occupied, the seat back switch S5 opens and after a short length of the belt 110 has been withdrawn for use, against the braking effect of the friction disc 134 and the diaphragm 136, switch S7 closes so energising the solenoid 142 through the buckle switch S4. Belt withdrawal is then opposed only by the spring 132, and when it has been completed, the buckle parts 126 and 128 connected together, and any slack taken up, all three of switches S4, S5 and S6 will be open, so the solenoid is de-energised to provide belt tension relief for the user.

Should the user lean forward, the seat back switch S5 closes to energise the solenoid and allow belt withdrawal to accommodate this movement. The retractor spring 132 will retract this extra length of belt as the user leans back until such time as he opens the switch S5, when the normal tension relief condition is again reached. Should emergency conditions arise, the retractor 122 will be locked against belt withdrawal if the locking mechanism is belt sensitive, because the user will tend to be thrown forward, so opening the switch S5. The belt movement consequential upon this forward movement is then freely conveyed to the locking mechanism.

When the system is put out of use, the buckle parts 126 and 128 are disconnected to close switch S4 and energise the solenoid to allow belt retraction until a sufficient length of the belt 110 has accumulated on the spool 4 to open the switch S7, when the initial position, with the solenoid de-energised, is restored.

It will be noted that the solenoid 142 is called upon only to overcome the resilient bias of the diaphragm 136 during belt withdrawal and retraction, and it consequently does not have to be continuously rated. The solenoid needed can be smaller than in embodiments in which a solenoid is continuously energised in use of the seat belt system.

It will be evident that the illustrated embodiments of the invention can be modified in a variety of ways. For example, the solenoid plunger 26 of Figure 2 could apply a non-rotatable braking element directly to the retraction spring in the cup member 16. The embodiment of Figure 5 could be modified so that the spool cup member 62 has, in place of the teeth 60, a friction surface engageable with a solenoid-operated pressure plate. Alternatively, the spool cup member can carry an annular friction disc engageable by a pressure plate movable axially of the spool by the solenoid which will in this modification have its axis extending parallel to the spool axis instead of at right angles to it as shown.

CLAIMS

1. A vehicle seat belt system comprising a retractor, the retractor having storage means from which a seat belt can be withdrawn for use and biassing means applying a retractive bias to the belt opposing such withdrawal, electrically actuable inhibitor means for rendering the biassing means at least partially ineffective, and sensor means arranged to change the condition of an electric circuit including the inhibitor means in response to the withdrawal of the belt for use to thereby actuate the inhibitor means.

2. A system as claimed in claim 1 wherein the inhibitor means is mounted on the retractor.

3. A system as claimed in claim 1 or 2 wherein the inhibitor means comprises a means for applying a clamping force on the belt.

4. A system as claimed in claim 3 wherein the inhibitor means comprises a fixed resistance surface and the belt is clamped between the surface and a solenoid operated brake pad.

5. A system as claimed in claim 1 wherein the storage means comprises a rotatable spool onto which the belt can be wound and from which it can be unwound, the inhibitor means being actuable to oppose rotation of the spool.

6. A system as claimed in claim 5 wherein the spool carries a friction plate for rotation therewith and a pressure plate is movable into and out of engagement with the friction plate.

7. A system as claimed in claim 6 wherein the pressure plate is part of a housing containing the spring.

8. A system as claimed in claim 5 wherein the biassing means comprises a spring spirally wound around the spool axis and wherein the inhibitor means comprises a friction member engageable with the spring edge forming one side of the spiral winding.

9. A system as claimed in claim 6 wherein the pressure plate is part of a housing containing the spring.

10. A system as claimed in claim 5 wherein the spool has a portion with a cylindrical outer surface, the surface carrying a series of spaced protrusions and wherein the inhibitor means element is movable radially of the spool into and out of engagement with the protrusions.

11. A system as claimed in claim 10 wherein the spool portion having the cylindrical outer surface portion encloses the spirally wound spring.

12. A system as claimed in claim 5 wherein the inhibitor means comprises a pawl engageable with a ratchet wheel fixed to rotate with the spool so as to prevent belt retraction.

13. A system as claimed in any preceding claim

wherein the inhibitor means is actuable by energization of a solenoid.

14. A system as claimed in claim 13 wherein the sensor means comprises a normally open buckle switch arranged to change condition on connection of a buckle to which the seat belt is connected.

15. A system as claimed in claim 14 wherein the buckle switch is in series with a normally open seat switch arranged to close on occupation of a vehicle seat with which the system is associated.

16. A system as claimed in claim 14 or 15 wherein the buckle switch is in series with a normally open tension switch arranged to close in response to tension in the seat belt.

17. A system as claimed in claim 13 wherein the sensor means comprises a belt switch arranged to change condition on withdrawal of a predetermined length of the belt from the retractor storage means.

18. A system as claimed in claim 13 wherein the sensor means comprises normally closed first and second switches arranged to open in response respectively to closure of a buckle to which the seat belt is attached and to engagement by a user of the system of a back portion of a vehicle seat with which the system is associated, and normally open third and fourth switches arranged to open in response respectively to a predetermined tension in the belt and to withdrawal from the retractor of a predetermined length of the belt, the first second and third switches being connected together in parallel and in series with the fourth switch and the solenoid.

19. A system as claimed in any preceding claim wherein the retractor incorporates means locking the retractor against belt withdrawal in response to a predetermined acceleration of the belt in withdrawal direction and/or a predetermined acceleration or deceleration of the retractor.

20. A vehicle seat belt retractor system substantially as herein described with reference to Figures 1-3, Figure 4, Figure 5, Figure 6, Figures 7-9 or Figures 10-15 of the accompanying drawings.

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